

What is claimed is:

1. A plasma processing apparatus for providing a plasma processing to an object to be processed disposed within a vacuum processing chamber, the plasma processing apparatus comprising:

a vacuum processing chamber;

a process gas feeding device for feeding process gas into the vacuum processing chamber;

a wafer electrode placed within the vacuum processing chamber for mounting the object to be processed;

a wafer bias power generator for applying self-bias voltage to the wafer electrode;

a plasma generating means for generating plasma within the vacuum processing chamber; and

a high frequency voltage waveform control circuit for flattening either a positive side voltage or a negative side voltage of the voltage waveform of a high frequency voltage generated to the object to be processed to an arbitrary voltage.

2. A plasma processing apparatus for providing a plasma processing to an object to be processed disposed within a vacuum processing chamber, the plasma processing apparatus comprising:

a vacuum processing chamber;

a process gas feeding device for feeding process gas into the vacuum processing chamber;

a wafer electrode placed within the vacuum processing chamber for mounting the object to be processed;

a wafer bias power generator for applying self-bias voltage to the wafer electrode;

a plasma generating means for generating plasma within the vacuum processing chamber; and

a clip circuit provided to the wafer bias power generator for clipping at least either a positive side voltage or a negative side voltage of a high frequency voltage to a predetermined voltage.

3. A plasma processing apparatus for providing a plasma processing to an object to be processed disposed within a vacuum processing chamber, the plasma processing apparatus comprising:

a vacuum processing chamber;

a process gas feeding device for feeding process gas into the vacuum processing chamber;

a wafer electrode placed within the vacuum processing chamber for mounting the object to be processed;

a wafer bias power generator for applying self-bias voltage to the wafer electrode;

a plasma generating means for generating plasma within the vacuum processing chamber; and

a clip circuit provided to the wafer bias power generator for clipping at least either a positive side voltage or a negative side voltage of a high frequency voltage to a voltage that varies in an inclined manner with time.

4. A plasma processing apparatus for providing a plasma processing to an object to be processed disposed within a vacuum processing chamber, the plasma processing apparatus comprising:

a vacuum processing chamber;

a process gas feeding device for feeding process gas into the vacuum processing chamber;

a wafer electrode placed within the vacuum processing chamber for mounting the object to be processed;

a wafer bias power generator for applying self-bias voltage to the wafer electrode;

a plasma generating means for generating plasma within the vacuum processing chamber, the plasma generating means comprising an antenna disposed within the vacuum processing chamber for supplying high frequency power inside the chamber to generate plasma, and an antenna bias power supply for supplying an antenna bias voltage to the antenna; and

a clip circuit provided to the wafer bias power generator for clipping at least either a positive side voltage or a negative side voltage of a high frequency voltage to a predetermined voltage.

5. A plasma processing apparatus according to any one of claims 1, 2 or 3, wherein the clip circuit comprises a diode and a DC voltage unit that are mutually connected in series, controlling the voltage of the DC power supply unit in order to adjust the inclination of the clip voltage that varies with

time.

6. A plasma processing apparatus according to any one of claims 1 through 4, wherein the wafer bias power generator supplies a voltage being clipped by the clip circuit to the object via an electrostatic chucking circuit and a capacitor for interrupting a DC component from entering the electrostatic chucking circuit.

7. A plasma processing apparatus according to claim 4, wherein the frequency of the wafer bias power generator is equal to the frequency of the antenna bias power supply but substantially in opposite phase.

8. A plasma processing apparatus according to any one of claims 1 through 4, wherein the wafer bias power generator is a time modulation high frequency power supply turning on and off at a predetermined duty ratio.

9. A plasma processing apparatus comprising:

a processing chamber to which is connected an evacuator for depressurizing the interior of the processing chamber;

a plasma generating means for generating plasma within the processing chamber;

a gas feeding device for feeding gas into the processing chamber; and

a means for applying high frequency voltage to an object to be processed so that the waveform of a high frequency voltage generated at the object is substantially rectangular.

10. A plasma processing apparatus according to claim 9, wherein the means for applying high frequency voltage to an object to be processed so that the waveform of a high frequency voltage generated at the object is substantially rectangular comprises a high frequency power supply for generating rectangular waves and a high frequency voltage waveform control circuit (sag compensation circuit) for increasing with time the absolute value of at least either a positive side voltage or a negative side voltage of the rectangular high frequency voltage.

11. A plasma processing apparatus according to claim 10, wherein the high frequency voltage waveform control circuit is a clip circuit comprising semiconductor elements such as diodes and FETs, and capacitors.

12. A plasma processing apparatus according to any one of claims 1 through 4 or claim 9, wherein the plasma processing apparatus further comprises a sensor for flattening the voltage waveform of the object to be processed.

13. A plasma processing method for providing a plasma processing to an object to be processed disposed within a vacuum

processing chamber, comprising a vacuum processing chamber; a process gas feeding device for feeding process gas into the vacuum processing chamber; a wafer electrode placed within the vacuum processing chamber for mounting the object to be processed; a wafer bias power generator for applying self-bias voltage to the wafer electrode; and a plasma generating means for generating plasma within the vacuum processing chamber; wherein

the plasma processing method flattens either a positive side voltage or a negative side voltage of a voltage waveform of a high frequency voltage generated to the object at an arbitrary voltage.

14. A plasma processing method for providing a plasma processing to an object to be processed disposed within a vacuum processing chamber, comprising a vacuum processing chamber; a process gas feeding device for feeding process gas into the vacuum processing chamber; a wafer electrode placed within the vacuum processing chamber for mounting the object to be processed; a wafer bias power generator for applying self-bias voltage to the wafer electrode; and a plasma generating means for generating plasma within the vacuum processing chamber; wherein

the plasma processing method clips at least either a positive side voltage or a negative side voltage of a high frequency voltage of the wafer bias power generator to a predetermined voltage.

15. A plasma processing method for providing a plasma

processing to an object to be processed disposed within a vacuum processing chamber, comprising a vacuum processing chamber; a process gas feeding device for applying process gas into the vacuum processing chamber; a wafer electrode placed within the vacuum processing chamber for mounting the object to be processed; a wafer bias power generator for applying self-bias voltage to the wafer electrode; and a plasma generating means for generating plasma within the vacuum processing chamber; wherein

the plasma processing method clips at least either a positive side voltage or a negative side voltage of a high frequency voltage of the wafer bias power generator to a voltage that varies in an inclined manner with time.

16. A plasma processing method according to any one of claims 13 through 15, wherein the means for clipping voltage comprises a diode and a DC voltage unit that are mutually connected in series, controlling the voltage of the DC power supply unit in order to adjust the inclination of the clip voltage that varies with time.

17. A plasma processing method according to any one of claims 13 through 15, wherein the wafer bias power generator is a time modulation high frequency power supply turning on and off at a predetermined duty ratio.

18. A plasma processing method utilizing a plasma processing apparatus comprising a processing chamber to which is connected an evacuator for depressurizing the interior of the processing chamber; a plasma generating means for generating plasma within the processing chamber; a means for applying high frequency voltage to an object to be processed; and a gas feeding device for feeding gas into the processing chamber; wherein

the plasma processing method applies high frequency voltage to the object to be processed so that a high frequency voltage waveform generated at the object is substantially rectangular.

19. A plasma processing method according to claim 18, wherein the duty ratio of the rectangular high frequency voltage is varied according to the processing conditions of the object to be processed.

20. A plasma processing method according to any one of claims 13 through 15 or claim 18, wherein a sensor outputting a value related to the voltage generated to the object to be processed is used to flatten the voltage waveform of the object.